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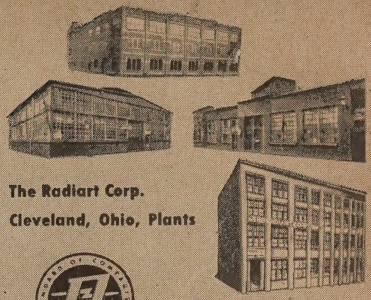

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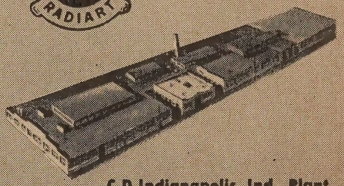

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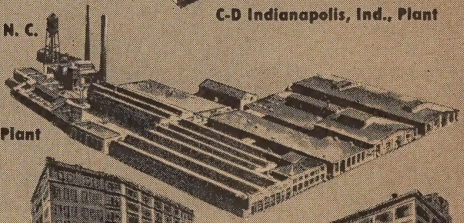

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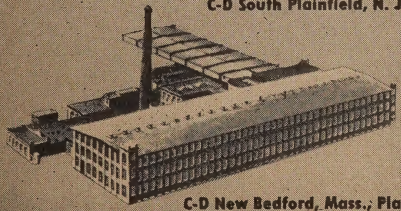

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INTERMODULATION, UP TO DATE

During the past ten years, a respectable amount of material, both theoretical and applicative, has been written about intermodulation distortion and its measurement. The August, 1951 issue of the C-D CAPACITOR featured an explanatory article on intermodulation which was received favorably by high-fidelity audio enthusiasts. The measurement of intermodulation is important in testing the fidelity of audio equipment.

Important strides have been made recently toward the acceptance of intermodulation measurement as a significant performance test. A review of the present status of the art therefore is in order.

Since the subject of intermodulation now is understood by many audio technicians at all levels, it is well at this time to discuss the subject in somewhat more detail than in our first article and to appraise presently-used methods of measurement.

The Nature of Intermodulation

A faithful audio system, such as an amplifier, is a linear system. That is, its a. c. output voltage will follow uniformly any variations in signal input voltage. Within the correct operating range of an amplifier, for example, doubling the signal input voltage will double the output voltage, tripling the input triples the output, etc., when the amplifier is linear. When the input-output characteristic is non-linear, distortion is said to be present.

For many years, the standard method of checking amplifier non-linearity (and also the non-linearity of certain audio components, such as transformers) with reasonable speed consisted of measuring the harmonic distortion. Two common methods were available: measurement of total distortion with a distortion meter, and measuring each of the individual harmonic components of distortion with a wave analyzer. Each of these methods necessitates applying a distortion-free test signal to the amplifier or component under test. Obtaining such a pure test signal often involves a great deal of expense and complication.

A decided disadvantage of harmonic distortion measurement is that it does not always agree with actual listening tests. A low distortion percentage, which would be accepted as a good fidelity rating, does not insure that an amplifier will sound right. Inasmuch as the ear does not recognize very small amounts of harmonic distortion, the conclusion was soon reached that distortion of another sort must be present in amplifying and reproducing equipment.

That other kind of distortion shows up as the ability of a non-linear amplifier to produce extraneous frequencies when two or more separate frequencies are passing through the amplifier simultaneously. In practical operation, such as the reproduction of music, the amplifier usually is handling more than one frequency at a time, and non-linearity of the system will cause these frequencies to interact and produce frequency by-products. When these new frequencies are not harmonically related to the original frequencies, annoying discords are produced. The ear is quite sensitive to these discords even when the latter are weak. The production of such frequency by-products is due to intermodulation between the original frequency components.

Severe intermodulation, at least insofar as the ear is concerned, may be present in company with acceptably low percentages of harmonic distortion, although this is not always true. For that reason, it is important that intermodulation tests be made even

when conventional harmonic distortion measurements indicate that an amplifier has high fidelity characteristics.

At this writing, unfortunately, there is no simple numerical relationship between harmonic and intermodulation distortion figures. Therefore, we cannot estimate the one in terms of measured values of the other. An amplifier with high harmonic distortion may or may not have high intermodulation, and the reverse also is true. While both sets of measurements should be made on an amplifier, when the operator is restricted to only one test method, it appears likely that an intermodulation measurement would be the most reliable **single** test.

Unlike harmonic distortion measurement, which requires a pure sine-wave test signal source, intermodulation measurements often may be made satisfactorily for practical purposes with signals from inexpensive audio oscillators having themselves reasonable amounts of harmonic distortion. This is an important advantage when instrumentation cost is a factor to be considered.

There are several methods of intermodulation measurement in current use. The important ones of these will be described in this article. All involve the application simultaneously of two test signals of different frequency to the amplifier under test, and making certain measurements on the output signal to determine the extent of interaction (intermodulation) due to non-linearity of the amplifier. If no interaction at all can be detected in the output voltage, there has been no intermodulation and non-linearity may be assumed to be quite low, if present at all.

When two pure-tone test signals of different frequency are passed simultaneously through a non-linear amplifier, the output voltage will contain (in addition to the two original frequencies) sums and differences of the two frequencies and their harmonics. Thus; if the two test frequencies are a low frequency F and a high frequency f, the output will consist of F, f, f — F, and f + F. The two latter are sidebands.

If the low-frequency test signal F has a strong 2nd harmonic (2F) which cannot be neglected, and the high-frequency test signal f likewise has a strong 2nd harmonic (2f), the condition becomes more complicated. The output then will contain F, f, 2F, 2f, f + F, f — F, f + 2F, f — 2F, 2f + F, 2f — F, 2f + 2F, and 2f — 2F. If strong 3rd, 4th, 5th, etc., harmonics also are present, additional extraneous frequencies will be generated. Furthermore, the various sums and differences will interact to produce still other frequencies.

As will be seen from the relationships in the preceding paragraph, many of the spurious frequencies are not harmonically related, and therefore will produce dissonances. Also, since these frequency by-products are grouped closely around the original frequencies, they will tend to "fuzz" the latter and impair tone quality, producing a decidedly displeasing aural effect.

It is interecting to note that the frequencies produced by intermodulation distortion can be lower, as well as higher than the original high-frequency component. Harmonic distortion, on the other hand, produces extraneous frequencies which are higher than a given applied frequency. Intermodulation distortion may be generated in the amplifier, in the pickup device ahead of the amplifier, or in the loudspeaker following the amplifier.

Harmonic distortion measurements appraise amplifier performance in terms of single sine-wave test frequencies — single pure tones. The amplifier seldom is used in actual practice to reproduce such single tones. Both music and speech are composed of complex

waves containing many frequency components. When intermodulation distortion is present, these frequencies modulate each other and set up by-products which are disagreeable to the listener. Thus, a measurement of harmonic distortion would fail to "catch" the defect causing poor reproduction quality, while an intermodulation test would.

Present Systems of Measurement

In all forms of intermodulation measurement, test signals of two different frequencies are applied simultaneously to the input of the amplifier or system under test and quantitative measurements made on the output signal. Measurement systems in present use differ chiefly in the method of measuring the intermodulation component in the output signal. The two accepted methods are described in the following paragraphs.

SMPTE (Society of Motion Picture & Television Engineers) Method. In this method of measurement, a low- and a high-frequency signal are applied simultaneously to the unit under test. Measurements then are made on the output signal to determine the percentage of modulation of the high frequency by the low frequency. This system has been applied to a considerable extent in the motion picture industry.

The technique essentially is the same as the measurement of amplitude modulation percentage in radio transmitters. Either a specially designed direct-reading-meter type intermodulation indicator or an oscilloscope may be used. The application of both instruments is described in the August, 1951 issue of the C-D CAPACITOR.

Different amounts of intermodulation can be expected for different combinations of low- and high-frequency test signals. Different amounts may be expected too for different ratios of amplitudes of the two signals. The SMPTE has standardized the signal amplitude ratio of 4:1. That is, the low-frequency test signal amplitude is adjusted to 4 times that of the high-frequency signal.

The test signal frequencies may be selected over a wide range. It has become common to employ 60 cycles as the low test frequency, since this value is obtained so easily from the power line and simplifies the requirement of a 2-signal generator for intermodulation testing. However, experience points to the advisability of employing several low frequencies as well as several high frequencies. The Western Electric RA-1258 Intermodulation Signal Generator, as an example, supplies low frequencies of 40, 60, 100, and 150 cycles, and high frequencies of 1000, 2,000, 7,000, and 12,000 cycles. Recently, the Heath Company has made available, for private assembly, their Model IM-1 Intermodulation Analyzer, based upon the SMPTE system. This unit contains a signal source which supplies a single 60-cycle low test frequency and 3000- and 7000-cycle high frequencies.

Use of an oscilloscope in checking intermodulation by the SMPTE method appeals to numerous audio enthusiasts because of the comparatively easy availability of this instrument. The only external accessory usually required is a high-pass filter which is inserted between the vertical amplifier input terminals of the oscilloscope and the output terminals of the unit under test. The purpose of this filter is to remove the low-frequency test signal from the output and to deliver to the oscilloscope only the modulated high-frequency component.

It is well to examine the operating requirements of this filter in the light of experience in intermodulation testing. For economy and simplicity, the tendency is to use a resistance-capacitance type of filter. Such an R-C unit is described in the August, 1951 issue of the C-D CAPACITOR. The R-C filter is not suitable for all conditions of intermodulation, especially those requiring the measurement of very small

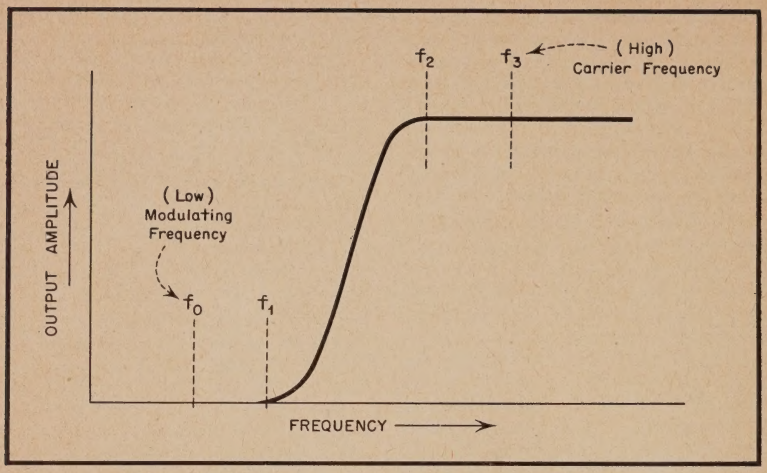

Fig. 1. High-Pass Characteristic of Intermodulation Filter.

percentages, as will be seen from the following discussion.

Figure 1 shows the ideal response curve of a high-pass filter suitable for intermodulation measurements by the SMPTE method. In order to allow measurement of low percentages with accuracy, and to permit a variety of low- and high-frequency test signals to be used, the filter transmission characteristic must have sharp cutoff and high attenuation for unwanted frequencies.

All frequencies higher than f_2 must be passed with uniform gain. However, the point f_2 at which the filter low-frequency response begins to fall off should not be higher than a frequency equal to the carrier, minus 4 times the highest modulating frequency that will be used. This will permit all usually important harmonics of the modulating frequency, which have modulated the carrier, to be passed uniformly. The carrier frequency itself is represented by f_3. Thus, if a 3000-cycle carrier and 50-cycle modulating frequency are employed, frequency f_2 will be equal to 3000— (4 x 50) or 2800 cycles. The region beyond f_3 should be passed uniformly up to the 4th harmonic of carrier frequency f_3. Thus, in the case just given the flat-top portion of the pass region should extend at least to 4 (3000) or 12,000 cycles.

Frequency f_1 at which the filter response has fallen to its lowest value after the low-frequency cutoff, should not be lower than the 4th harmonic of the highest modulating frequency which will be employed. Thus, the modulating frequency itself will be located at f_0. Furthermore, the filter response at f_1 must be somewhat lower, with respect to f_2, than the lowest percentage of intermodulation which is to be measured. Thus, if 1 percent is to be measured, the response at f_1 must be much lower than one-hundredth of the response at f_2.

With any high-pass intermodulation filter, therefore, the highest modulating frequency used would be $\frac{1}{4}$ f_1; the lowest carrier frequency would be $f_2 + 4f_0$. Any variety of low test frequencies up to f_0 then might be used, and any variety of high test frequencies (carriers) down to $f_2 + 4f_0$.

Stringent requirements of sharp cut-off, high attenuation, flat-top transmission, and low insertion loss dictate the use of high-quality L-C filters (See Figure 2) employing high-Q coils and capacitors in all exacting measurements of intermodulation (SMPTE) with the oscilloscope. A representative small-sized commercial high-pass filter employing permalloy dust toroid coils has the following characteristics: f_1 500 cycles, f_2 700 cycles, response at f_1 40 db below that at f_2 (one-hundredth of response at f_2). This filter will provide the following frequency characteristics: low-frequency test signal 125 cycles and lower; high-frequency test signal 1200 cycles and higher. Other commercial filters with higher f_2 ratings will enable a wider range of low-frequency test signals.

CCIF (International Telephonic Consultative Committee) Method. This second method of measurement involves measuring the amplitude of the difference-frequency beat note in the output signal when two equal-amplitude test signals (one low-frequency and one high-frequency) are applied simultaneously to the unit under test. If there were no intermodulation at all, no beat note would be present in the output. A number of low- and high-frequency test signals may be employed in combination. Often, it is convenient to choose these test frequencies such that the same difference frequency always is obtained. The beat-frequency amplitude values then may be plotted against values of either the low or high frequency, to yield an intermodulation curve for the device under test.

In addition to the usual 2-frequency signal source, a wave analyzer (or in lieu of this instrument, a sharply-tuned single-frequency amplifier followed by an a. c. vacuum-tube voltmeter-milli-

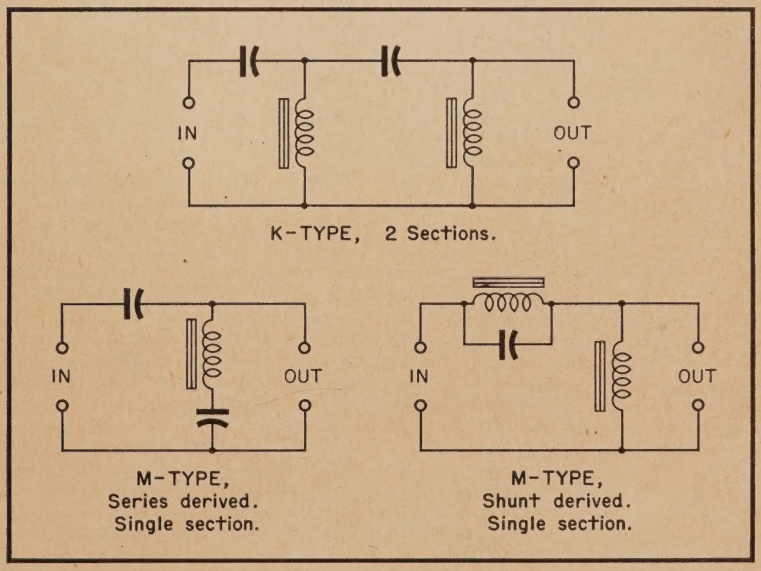

Fig. 2. L-C-Type High-Pass Filters.

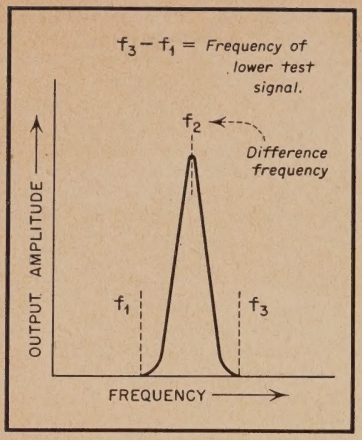

Fig. 3. Pass Characteristic of Analyzer for CCIF Method.

voltmeter) is required for the CCIF method of intermodulation measurement. This instrument is required for tuning to the difference-frequency beat note. The maximum selectivity of the analyzer or selective amplifier must be such that the pass bandwidth between the points of maximum rejection is no greater than the lowest low-frequency test signal frequency that will be used (See Figure 3). If, for example, a difference frequency of 1000 cycles is chosen, and the lowest low-frequency test signal is to be 50 cycles, the amplifier or analyzer must tune to 1000 cycles, with 975 cycles and 1025 cycles at points of maximum rejection. The latter points ought to be 60 db down. That is, the response at these points should be 1/1000 of that at the 1000-cycle peak. This limits any undesired signal component to 0.1% of the signal at the peak of the pass band.

Some authorities prefer the CCIF method of measurement to the SMPTE method because the former appears to correlate more closely with extensive listening tests.

Requirements for Intermodulation Testing

It is important that an amplifier or component under test be capable of passing faithfully both of the test frequencies selected for intermodulation checking. If the CCIF method is employed, the amplifier also must be capable of passing the difference frequency. This necessitates making a frequency response check of the unit before undertaking the intermodulation test, and would rule out the earlier concept of intermodulation as a "single" test.

In order to obtain a complete picture of intermodulation characteristics in a sound reproduction system, it is advisable to include the loudspeaker in the test setup. The intermodulation testing equipment may be connected to the voice coil of the speaker. When a satisfactory flat-response microphone (artificial ear) is available, it may be connected to the input of the intermodulation analyzer to pick up acoustic signals direct from the loudspeaker. Intermodulation test records are available for feeding a 2-frequency test signal into the system through the phonograph pickup.

Intermodulation measurements should be made at several input signal levels (while maintaining the same constant ratio between low- and high-frequency test signal amplitudes) and at several settings of both the volume and tone controls in the amplifier under test. When this is done with several combinations of test frequencies, a complete appraisal of intermodulation distortion will be obtained.

When checking intermodulation distortion of a transformer, the transformer should be terminated with the impedance into which it operates normally. A terminating resistor should be used only when the normal load is resistive.

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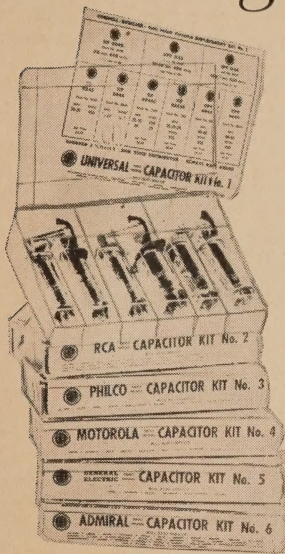
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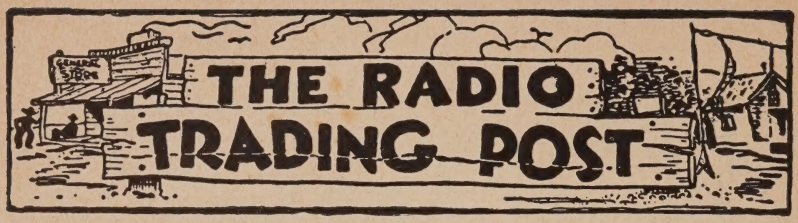

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FOR SALE—Weston analyzer $10; Eico VT-VM $15; Hickok VOM $20; radio surplus parts grab bag $1, worth $10. J. Willis, 61 Hayes Lane, Wilkes-Barre, Pa.

TRADE—Wagner-Nicholas "Embosser" disc recorder and playback, never used, for good "5" scope (no kits) or good "3" Dumont, cutting head and mike not incl. Comp. port., brown leatherette case. H. F. Moore, 78 Upland, Ave., Upland, Pa.

FOR SALE—160 meter fone rig, 35W on 1 chassis, 807 final-666 mods. separate amt. tuner with RF meter $75; DeForest radio course $75, all parts incl., oscilloscope etc. D. W. Peters, Lake in the Hills, Algonquin, Ill.

SALE OR TRADE—Meters DC 0-6, DC 0-8-200; RF thermo-milliammeter 0-125, AC 0-4-8-16-160, and Triplett tube tester meter. Edward J. Lee, 211 Fourth St., Fall River, Mass.

SALE OR TRADE—4 lbs. no. 28, 3 lbs. no. 18 enameled wire; 3½ lbs. 32-34 silk or enameled coils; Supreme analyzer, many parts, tubes. Need FM sweep or scope, kit type preferred. Bass Radio Shop, Lamoni, Iowa.

FOR SALE—Hallicrafters S-20R like new, best offer; Wilcox-Gay tape recorder $79; 16" TV rec. 24-tube chassis less pic. tube $79.95; 3-speed record changers $19.95; Universal auto radios $34; many other bargains. E. Bazzurro, 2625 3rd Ave., New York, N. Y.

FOR SALE—Meissner EX sig. shifter., incl. 160 m. coil strip and rack panel $65; Hallicrafters S-53 rcvr $42; 803's, 804's, 304-TL's, BC-454's, etc. G. H. Goldstone, 1745 W. Boston, Detroit 6, Mich.

TRADE—20 assorted schematics and service notes on radio, TV, auto radio and record players. Want band saw and man. control head for Motorola 409 auto radio (1950 Ford fit). Selcraft, Box 394, Spring Valley, N. Y.

SALE OR SWAP—2 mica condensers, .01 mfd. at 5,000 V.A.C.; 1 mica condenser .00025 mfd. at 8,000 V.. Want Simpson mutual cond. tube tester. C. Gabler, 1307 Merriam Ave., New York 52, N. Y.

FOR SALE—Clipon volt ammeter "Amprobe" mod. A6, 0-10, 25, 50, 100, 250 amps. AC; 0-150, 600 V AC, $35. W. Richman, 3438 90 St., Jackson Hts. 72, N. Y.

TRADE—Rider record changer man., DeForest Radio Course, National 5886 power supply for HFS rec., co-ax connectors. Need mod. transformers for single 807 and pair 814s, late Heathkits. D. C. Harrington, 2137-D 43rd St., Los Alamos, N. Mex.

FOR SALE—(no trades) GE test meter, (never used) V.M.3, $20 exp. coll. Frank E. Wooley, c-o Westinghouse (Meter Division) (Dept. I-4 Lab.), Newark, N. J.

FOR SALE—Radio City Dynatracer mod. 777A; Triplett VOM mod. 630, both like new; Sylvania tube tester, 2 yrs. old. Best offer, will ship postpaid. Coan F. Whitlock, R.R. 2, Farmersburg, Ind.

TRADE—3" cathode ray oscilloscope, Dumont mod. 164E, never used, for good tape recorder or what have you? Sidney Lebowitz, 145 Branford St., Hartford, Conn.

FOR SALE—1951 5" Heath oscilloscope mod. O-6, never used, pro. workmanship, with instruction book $40. Wm. Levine, 67-22 218 St., Bayside 64, N. Y.

SELL OR TRADE—Hickok mod. 305 oscillograph in perf. cond. for NC57 rec. or other H-F receiving eqpt. Cloyd's Radio Shop, 454 So. 3rd St., Hamilton, Ohio.

WANTED—Rider man. 1-15 like new. State price or what do you want? Might also take Riders 16 to present vol. if reas. H. O. Lenhart, 3226 Randolph Ave., Oakland 2, Calif.

FOR SALE—Columbus E.C.O. $38; 6-10-11 AC converter $38; mobile 6 meter and 10-11 meter converter $25. John Wasiewicz, 74 Canterbury, White Plains, N. Y.

FOR SALE—Transmitting transformers all sizes filament, plate up to 1800VA, audio, telephone, and chokes; dozen Triplett meters; tubes. A. Stratmoen, Box 536, Lock Haven, Pa.

FOR SALE—Electronic Co. sig. gen., spot freq. by pushing switches; covers 175Kc, 262, 370, 455, 465, 1000, 600, 1400, 2Mc., 5, 7.5, 20, $25, post. collect. H. M. Books, Jr., 318 11th St., New Cumberland, Pa.

FOR SALE—Rider man. 1-15 comp. and Sam's Photofacts 1-165 comp. in binders, cond. exc. R. E. Schlosser, 503 Fifth St., Defiance, Ohio.

TRADE—Heavy duty comm. electric Singer hemstitching machine mod. 72 W 19, comp. rebuilt at cost of $80, for Rider Man. 1-20, sig. gen., condensers, checkers, Sam's man., late tube tester, or ? Radio Sales Service, Ewing W. Little, Ladonia, Tex.

SALE OR TRADE—WE electric dynamic mike, salt shaker type, $40 or scope, ham eqpt., or what have you. Howard Haftel, 1651 Montgomery Ave., Bronx 53, N. Y.

SALE OR SWAP—Rider man. 1-11 and several Sam's man., $75 or swap for guns or what have you. Dick Miller, 1934 E. Broadway, Muskegon, Mich.

SELL OR TRADE—BC696, BC459 like new, both for $25; NRI 80 M CW trans. $20 or what have you? Joe Anderson, 909 W. Nevada Ave., St. Paul 3, Minn.

FOR SALE—App'd Electronic field strength meter mod. A 460 $59. Jerrold Mul-TV system. Carrs Television Center, 15-17 Kelley Sq., Worcester 4, Mass.

FOR SALE—Closing shop. 2" oval spkrs, Thordarson universal driver and interstage xfmrs T-19DO3, T-45665-B, 8000 ohm headsets H-16 and handsets TS-13-C. Write for comp. list. Dallin H. Oaks, 45 N. 6th, E. Provo, Utah.

FOR SALE—Thordarson mod. trans. 807's to 829 $10; 500 V. .9 A. power trans. $12; driver trans. 6SN7 to 807's $3; sig. calib. $20; analyst $50; Brush mike BR-2 $5. H. Lord, 64 S. Elliott Pl., Bklyn., N. Y.

FOR SALE—SCR 522 and SCR 522 trans. $10 ea., like new; SCR 518 altimeter comp. $50; T27/APT 3 transmitter. Peter Dal Corobbo, 10441 Corliss Ave., Chicago 28, Ill.

TRADE—5CP1 scope tube with xformer; Gen. Radio Variac type 200 B; Radio City multitester mod. 540 A, for cash or what have you? Victor Stella, 429 E. 147 St., Bronx 55, N. Y.

FOR SALE—Motorola mod. CTI-six tube push button radio to fit 1951 and '52 Chev. in sealed cartons, $55 FOB. Signal Radio, 2077 Coney Island Av., Brooklyn 23, N. Y.

SWAP—Rolleicord II with Hartley field lens, Heiland flash, case, etc.; exc. cond. Want 3¼ x 4¼ Ann. Speed Graphic with flash, holders and film pack adapter. Don Schleich, 3358 Karl Road, Columbus, 11, Ohio.

FOR SALE—Sam's PhotoFacts 1-66 like new $50 prepaid; Rider man. 1-3, 6-10, 12, all $75; ea. $10 prepaid. R. G. Dunbar, 571 Edinburgh St., San Francisco 12, Calif.

TRADE—$50 or more worth of radio eqpt. and parts. Will trade for set of golf clubs. George Arnold, Radio Shop, Roxana, Ill.

WANTED—TBY antenna, also comp. 474 (BC474) trans. and rcvr. M. J. Douglas, 1401 Amador St., Concord, Calif.

SALE OR TRADE—Abbott TR-4, trans. and rec. with new power supply. Want 16 mm sound eqpt., or comm. rec. Wm. H. Lorimer, 432 Sheridan St., Williamsport, Pa.

FOR SALE—Magazines, Radio News, Radio-Electronics, QST, Service, etc. Minimum asst. of 12 mixed for $1; add postage. Walter Bruskiewicz, 1458 N. Ashland Ave., Chicago, Ill.

SELL OR TRADE—20 W audio amp., like new $35; Speco sig. tracer $15, many types tubes 49c ea. Sell or trade for late mod. portable typewriter in good cond. S. Consalvo, 2507 Southern Ave. SE, Washington 20, D. C.

SALE OR TRADE—Surplus Triumph multimeter with carrying strap; Supreme mod. 541 multimeter; Philco mod. 46-132 radio (A-B pack). Want M98 Mauser 8mm rifle or outboard motor. B. R. Wilson, 1535 Harrison St., Memphis 8, Tenn.

FOR SALE—NRI Radio, TV and Comm. course in 5 loose leaf binders, less exp. kits $35. Edward Kielar, 1051 W. 21st St., Lorain, Ohio.

FOR SALE—8 6B4; 6 35TG; 10 24G; 3 8025; SPST; 110 V. relays 2 mfd. 2000 V.; CD cond.; 2000 resistors, ½-1-2 W.; asst. 3 electric clocks, radio service inscribed. M. Schmitz, 2135 W. Berteau Ave., Chicago 18, Ill.

FOR SALE—Eico V.T. voltmeter and hi-voltage probe mod. 221, wired, never used, $30 FOB. A. A. Gable, 3510 W. 48th St., Cleveland 2, Ohio.

FOR SALE—National HFS and power supply, perf. cond., cost $165; make offer. E. N. Christner, 313 Crawford St., Middletown, Ohio.

FOR SALE—BC 342 short wave rec. 1500-18,000 Mc., $95 with instr. book, exc. cond. Chester C. MacDonald, 129 Oakisland St., Revere 51, Mass.

FOR SALE—Rider man. vol. 7, like new; make offer. David Salzman, 2 Chester Court, Brooklyn 25, N. Y.

FOR SALE—200 carbon resistors, 1 10" heavy duty spkr. Send offer. James A. Smith, Oakwood Rd., Gainesville, Ga.

WANTED—Hickok indicating traceometer, mod. 155, 156, cash. For sale, Fairchild 541-A1 cutter, perf. cond. 1950, micro-groove advance ball, thermostylus. Frank York, Box 101, St. Albans 12, N. Y.

WANTED—Band saw. Will trade large assortment of tubes, radio and TV schematics and notes; list sent. Describe saw. H. Seligson, New City, N. Y.

FOR SALE—McMurdo-Silver Vomax $20; Approved Electronic A-200 sig. gen $25; Superior multimeter $10, all perf. cond. Max Bloodworth, 1313 Hillsboro St., Raleigh, N. C.

SWAP—EMC mod. 104, 20,000 ohms-per-volt, 0-3000 volts AC-DC, 0-20 megohms, 0-600 MA DC, 0-3 amp. AC; perfect. Want $20 worth of rec. tubes 50% off list for meter. C. Elgasser, Jr., 1920 Fern St., San Diego 2, Calif.

TRADE—Cinemaster II 8mm. movie camera, telephoto lens, filters, tripod, exposure meter, for tape recorder, tri-band converter, VHF 152, oscilloscope. W. M. McDonald, Box 351, Harrisville, R. I.

FOR SALE—Rider man. 11-16; $79.50 Cort wrist watch; Browning 12 ga. automatic; Feiller tracer stethoscope; 300 tubes. E. G. Bartlett, Box 86, Atlanta, Mo.

SWAP—Junior Scientific code course in first class cond. less exam. papers. Want .32 Colt automatic in A-1 shape. Rupert Freeman, 2108 33 Ave., Meridian, Miss.

FOR SALE—Knight PA system with turntable, 6-110 V. AC, DC 40 W; 2 12" spkrs; Electro-Voice dynamic mike, Hi-Z ohms with stand; price $85. Rev. Myron J. Malone, 728 State St., Osage, Iowa.

WANTED—High voltage transformer to deliver 2000 to 2500 volts at 300 MA. Must be priced reas. Bob Joy, 1215 Paquin St., Columbia, Mo.

FOR SALE—BC412A radar scope converted to oscilloscope, stand. conv. prints and all tubes incl.; needs little work, $25; Philco F1640 radio from '39 Mercury; plays good, $25. Will not ship either of above. Wm. Henshaw, 46 Front St. Tarrytown, N. Y.

WANTED—16mm silent films of interest to children. Have ham and photo gear to swap. L. Meister, 5 Highfield Lane, Nutley, N. J.

SALE OR TRADE—Home utility 1/4" drill; 3 port. radios; Astatic crystal mike; Hallicrafters S416, Radio City tube tester. Want comm. rec., xmitter, VTVM, sig. gen. Forrest E. Hancock, Laddonia, Mo.

OPPORTUNITY—Certified TV technician (colored) with comp. lab.; 7 yrs. TV, 25 yrs. radio; wishes a partnership with someone entering TV or wanting to add TV to present business. Call RO 4-5605-J after 6 PM or write Charles O. Luckett, 211 E. 8th Ave., Roselle, N. J.

SELL OR TRADE—Thordarson T-23V05 voltage reg., input pri. 95 to 135 v. a.c., output ± 1% 110, 115 or 120 v., 500 v.a. Cost $100 new, 70 lbs. Will trade on 1½ hp air compressor. John Sporna, Escatawpa, Ala.

WANTED—Rider Man. 18-22; Hallicrafter S-72; I.R.C. and Ohmite resistor cabinets with or without resistors; Hickok 450 VOM. State best price. G. H. Swiska, 109 E. School St., Woonsocket, R. I.

SELL OR SWAP—100' RG8/U, 100' Gonset open-wire line, like new, 15 w. 300v 6 v. vibrator supply, 522 xmtr-rec. in case, Thordarson T19M16 200 w. modulation xfmr., like new. Marc Molyneux, 8421 8th Ave. No., Birmingham 6, Ala.

FOR SALE—Alliance Tenna-Rotor mod. ATR, comp. with 100' 4 conductor cable $20; metal case intercom set, Master Station and 1 remote $15. Charles V. Commo, 5826 N. Fairhill St., Philadelphia 20, Pa.

WANTED—ART-13, ATC, DY-12, DY-17 and any ART-13 parts; TCS, SCR-694, BC-1306, PE-237, GN-58, BC-348, BC-312, 314, BC-342; tubes, radar, tech. and ref. man. T. Howard, Box 19, Boston 1, Mass.

FOR SALE—Maso tape recorder mod. 375, 1 hr. reel of tape, mike, earphones, tel. pickup, misc. equip.; used 20 hr. Leonard P. Orlowski, Dunlap, Iowa.

FOR SALE—Hickok mod. 195B 5" oscilloscope, used for display only, price $125. Roland G. Kempton, 50 Washington Rd., Scotia 2, N. Y.

SELL OR TRADE—Superior mod. 600-A VOM and tube tester; Sams Photofacts 1-10 with binder. Want Gonset 3-30 mc. mobile converter. R. L. Perryman, 521 N. State St., Lexington, N. C.

WANTED—RCA TV mod. 8PCS 41-B and RCA optical barrel KRK4. P. J. Rumbol, 1 E. Stewart Ave., Greenville, Pa.

SELL OR TRADE—Simpson 381 cond. tester, never used $25; Aerovax interference analyzer used once $15. Want bench saw, small lathe, or 4" or 6" jointer. Royce Saxton, R. 1, Pontiac, Ill.

FOR SALE—Foto Fact folder sets 1-37, cost $55, like new, $30 or best offer. Ernest E. LaBossiere, 394 Western Ave., Lynn, Mass.

WANTED—DC fans and motors, all types appliances and parts. Bismarck Electric Co., 26 Front St., New York, N. Y.

SWAP OR SELL—Famous 5-in-1 Magic Eye Tester, also - 7-in-1 Meter Tester. Am interested in old plate cameras any size, or what have you? Cabon, 4207 Council, Los Angeles 4, Calif.

SWAP—Will swap Standard typewriter for 35mm camera or test eqpt. John Trowbridge, 655 W. 81st St., Chicago 20, Ill.

WANTED—Inst. man. and prints for Sig. Corps vibrator power sup. 6-12-24, v. input PE-120 B; also Mark 11 trans-rec. and dynamotor supply. C. B. Kelley, 7204 Clovernook Ave., Cincinnati 31, Ohio.

WANTED—100 kc crystal for marker. Also need mobile eqpt. for 10 and 75, conv. VFO to drive 2E26 final, and power supply. Good home built eqpt. A. H. Davis, 34 W. Girard Blvd., Kenmore, N. Y.

SELL OR TRADE—Recond. radios, typewriters, watches; f4.5 German camera, opera glasses. Will trade for radio eqpt., TV, typewriters, late Riders, binoculars, guns, projectors, etc. G. R. Calvert, Box 637, Auburndale, Fla.

WANTED—Tape recorder, in working cond. Must be reasonable. Also RCA 630TS 15" set. John O. Hehn, 18 S. Jardin St., Shenandoah, Pa.

FOR SALE—Complete radio and TV shop at home. Large asst. of parts and tubes, test eqpt. Disabled vet must sell due to illness. Will accept reasonable offer. Harry L. Dean, Sr., 671 S. Saybrook Av., Los Angeles 22, Calif.

SALE OR SWAP—2000' 4 wire cable for ant. motor; Senital no. 423 table mod. 12½" set; Allied wire recorder; ant. top Electrovoice booster; Andrea TV 12" set with Due-view projector like new. H. Miller, Box 92, Trevorton, Pa.

WANTED—Grunow mod. 11A chassis only or certain components. Sell 2 GI 2-speed recorders. Jack Collinsworth, La Grange, Ga.

WANTED—Complete band switching linkage for mod. 8S661 Zenith or similar. I need knob, knob shaft, and connecting linkage to bandswitch. McCann Radio-TV, 129 E. Bdwy, Drumright, Okla.

TRADE—Waterman 2 inch pocket type scope, 100-1000 kc xtal calibrator with Natl parts and extra stage RF amp., heavy duty prop pitch changer to rotate antenna; also Polaroid 60-second camera with GE exp. meter. Want good mobile transmitter-power supply Gonset converter, etc. Bandmaster. R. E. Eubank, 1227 Windsor Ave., Richmond 27, Va.

SELL OR TRADE—BC625A, BC458, BC602A, Motorola no. 405 car radio, and misc. electronic and photo eqpt. A. Zambakian, 1259 Gaylord St., Denver 6, Colo.

WANTED—Boy Scout Radio Training Center of Queens wants good buy in 10 meter rig-fixed and mobile SCR522 transmitter with power supply, 80 meter novice band transmitter and rec. and power supplies. Must be reasonable. Saul Schacket, Box 131, Jamaica, L. I., N. Y.

SWAP—Astatic AT-1 booster for Mon-key in top cond. or pair of Wheeler sound-powered phones. A. L. Guide, 17 Wolcott St., Malden 48, Mass.

FOR SALE—Hallicrafter mod. S40A, exc. cond. $55. Chas. Cerami, 146 Congress St., Newark, N. J.

SALE OR TRADE—BC 344D rec.; 100-1500 kc, 115 v. 60 cy., with matching spkr; RBZ rec., battery port., 1.8-5.5 headphone output. Can use TV, TV test eqpt., good tube tester or cash. Karl E. Koehler, 2720 Sommers Ave., Madison 4, Wis.

FOR SALE—Precision tube tester mod. 912 $45; Supreme tube tester mod. 599 $35; Precision sig. Standard mod. E-300 $15; Meissner analyst $75. All States Radio Co., 2915 9th St. No., St. Petersburg, Fla.

FOR SALE—Davis & Phillips DX rhombic antennas $10 ea.; Jensen Bass reflex enclosure for a 12" spkr $20; also have trade list. Send yours to John Tanczyn, 1375 Agard Ave., Benton Harbor, Mich.

FOR SALE—Freq. meter mod. BC-221-E, 125 kc. to 20 mc. with built in reg. power supply. Make offer. Charles A. Richardson, 5912 N. Bingham St., Phila. 20, Pa.

WANTED—BC-348 rec.; state price and cond. in first reply. S. E. Rajkowski, 11-R Jones St., Pittsburgh 23, Pa.

WANTED—All types of clean, new and preferably boxed rec., trans., and special purpose vacuum tubes wanted. Will pay cash or swap for your needs. Send full details. B. N. Gensler, 136 Liberty St., New York 6, N. Y.

WANTED—Set of three coils each for prewar mod. Meissner deluxe sig. shifter covering 160, 80, and 40 meter bands. E. L. Thompson, 2740 Southside Blvd., Jacksonville 7, Fla.

WANTED—N.R.I. service manuals 1 and 2 in good condition." Kirk Lumsden, 1103 Arney St., Elizabethton, Tenn.

SALE OR TRADE—First 56 lessons of De-Forest's Radio & Electronics Course. Best offer. Kenneth D. Purdy, 112 W. Washington, Flora, Ill.

WANTED—Standard coil Cascode TV tuner no. 2032 or RCA printed circuit tuner no. 4P-12. Have to trade, 2 stage Channel Chief TV booster AT-1 Astatic. One single stage booster, one I.F. booster, 5" cr. tube, sig. gen, 5 bands. John Arnold, P.O.B. 84, Bluffs, Ill.

WANTED—Inst. man. for McMurdo Silver no. 900 Vomax; also no. 904 condenser resistor, McMurdo Silver Co. Aryl D. Aldred, 126 Elmhurst Ave., Elmhurst, Ill.

WANTED—Back issues of C-D Capacitor. Will make generous offer for all of vol. 1-14 inclusive, 1949; vol. 15 no. 7, 1950. J. N. Leon Daoust, Windsor Radio Electronics & Sports, Seminole at Rossini Blvd., Windsor, Ontario, Canada.

WANTED—16mm sound projector, good cond. Have several good TV sets to swap, 10", 12". What have you? Sid, c-o Stanhope Appliance, Co., Stanhope, N. J.

FOR SALE—Late model set and tube tester $25; 7½ v. dry A batt. $3; 5 dyn. spkrs. $2.50 ea. several 6.3 v. and 12.6 v. pwr. trns. at $1 ea. and other items. Evan H. Griffiths, Rock Creek Sta., Ohio.

FOR SALE—Midwest 15 tube chassis with 15" spkr, AM, FM and SW band. FM band out of order, 1947 mod. Shipped prepaid for $45. Thomas Johnson, Box 932, Tuscaloosa, Ala.

WANTED—Tube tester, good cond. and cheap. Write details. H. S. Barnes, Box 247, Roxana, Ill.

SWAP—Pre-amplifier, car radio, war surplus meter, etc. Want 9mm. German Luger, pref. with holster, in good cond. Will also trade for damaged Luger. Lloyd Schmit, R. 1 Brunnerdale Seminary, Canton, Ohio.

FOR SALE—Tel-ohmike cap. tester; Precision E200 sig. gen., Electronic Designs VTVM no. 100, 6 v. batt. eliminator, and vols. 1, 2, 4, 6 Riders. All in good cond. for $145. W. Taft Davis, 102 W. Woodridge Dr., Durham, N. C.

FOR SALE OR TRADE—Hallicrafters SX42; National 81X; Walther .32 automatic; bolt repeater .22 rifle, all exc. Want cash or hi-fi eqpt. Arthur Freund, 17-87 166 St., Whitestone, N. Y.

FOR SALE—Hickok 610A and 195B $225; Hickok 209A $100; Hickok 288X $100; Supreme 504 A tube and set tester $40; Meissner analyst $75; Simpson 260 roll top case $30; Simpson 303 VTVM $45. Seaman's Radio & TV, 1109 Main St., Hellertown, Pa.

SWAP—0-7 Heath scope and VTVM V-5 for Contax II F2 Sonnar, must be perf.; Also battery eliminator Heath BE-3 for 2¼ x 3¼ cond. type enlarger. S. Rand, 27 Forest Ave., Ossining, N. Y.

TRADE—Bausch-Lomb microscope; three objectives supplied: high power, low power and oil immersion lens. Also 3 oculars. Professional model, good cond. Want tape recorder in exchange. Walter Oldham, McLean Hosp., Belmont, Mass.

WANTED—Tube tester, 6 v. battery eliminator, radio parts and eqpt., books and magazines. Must be cheap. John P. Dzendzel, 829 Muhlenberg St., Reading, Pa.

SELL OR TRADE—Rabin rotary converter input DC 110 v. 3.3 amp. output AC 110 v. 2.27 amp., 60 cy. 100 P. fact., $25 or table mod. radio with record player. F. Spitz, 61 W. 74 St., New York 23, N. Y.

SELL OR SWAP—Warren Knight, Transit complete with tripod, worth $150. Want S-53, or ?; 2 Hartron mod. 60 film recorders with 60 rolls of film; most $1500 in 1948, not abused. Make offer. Nelson K. Stover, P. O. 722, York, Pa.

FOR SALE—Power supply used for ART-13, 1300 v. DC at 300 ma, 400 v. at 250 ma, 24 v. AC at 7 amp., 28 v. D.C. for relays, cable and connectors $50; PE-103 used 1 hour $25; components for power supply 24-28 v. DC at 15 amp. $20. A. Brocato, 101 Alden Place, New Orleans, La.

WANTED—Fada radio, 6 tube, series 1000, from 1945, '46, in yellow cabinet with red knobs and handle, as advertised in Radio News of 1946. Chester Wegrzynowski, 51 N. Central, Buffalo 12, N. Y.

FOR SALE—Transceiver BC-645; like new; transmitter BC-375-E; 7 tuning units; antenna tuning unit; dynamotor; McElroy keyer; Wilcox CW3 receiver. P. James, 243 Center St., Canandaigua, N. Y.

SWAP—5-element Yagi for channel 6, like new, for similar antenna for channel 4. R. T. Weir, 1901 Wyoming Ave., N. W., Washington 9, D. C.

WANTED—Rider's Encyclopedia on Cathode Ray Oscilloscopes and their uses. In good cond. I have "Modern Radio Servicing" by Ghirardi, and other books and magazines for sale or swap. Louis Leibovitz, 3835 Cambridge St., Philadelphia 4, Pa.

FOR SALE—Sam's Photofacts 1-136, $125 or best offer. Very good cond. D. E. Baisley, Jr., 81 Maple Ave., Northport, N. Y.

WANTED—Hickok TV sig. gen mod. 292X or 610A in A1 cond. Give cash price in reply. J. E. Crowder, Willis Wharf, Va.

WANTED—Circuit diagram and inst. man. for BC-310A radio compass rec. Bernard Artz, RFD 2, Tullahoma, Tenn.

SELL OR TRADE—Two meter transceiver in TU26B tuning case. Needs PE101C for 15 w. mobiling; built in AC powered 12 w.; rec. Sonar SR9, $75 or trade Hallicrafters SR75 transceiver. Sonar alone $45 or trade on SR75. R. E. Franklin, 239 E. Fourth Ave., Roselle, N. J.

FOR SALE—25 new Alliance, rim drive phono motors in cartons, 78 rpm, mod. 80, 110 v., 60 cy. with 9" turntables, $2.75 ea. FOB. Berger Bros. Elec. Motors, Inc., 395 State St., Rochester 14, N. Y.

SALE OR TRADE—Wire recorder and amp. mod. PA wire recorder with matching A-25 amp., like new with 5-1HR spools, orig. boxes and inst.; Cost $150, will sell for $99.50 FOB or trade for ham gear. Roger Bates, 4525 Fountain Ave., Hollywood 29, Calif.

SALE OR TRADE—Rider Man. 1-3 vols. combined, and vol. 9, exc. cond. $12. Want Ghirardi's "Radio & TV Trouble Shooting and Repair," and "Radio TV Circuitry and Operation." J. O. Basham, Altamont, Covington, Va.

FOR SALE—UTC output transformer LS-57, used slightly but perf. $10 postpaid. J. Leonard Herron, 6340 Magnolia Ave., Chicago 40, Ill.

WANTED—Push-button selector switch for Philco 39-30 rec. Have 8" to 10" dynamic spkrs. T. Kufta, 76 Hibernia Ave., Rockaway, N. J.

FOR SALE—Hallicrafter 7" TV $35; Teleking $90; BC 454, 3.5 m. c. receiver, converted $12; base reflex cabinet; $15 Table saw, drill press, paint sprayer, cash FOB. Johnson Dayes, 29 Charles St. Merrick, L. I., N. Y.

FOR SALE—One copy Henney's "Radio Engineering Handbook", third ed., like new; "QST", from Feb. '49 to Dec. '51, total 35 copies, A-1 cond. No swaps, best offer. Raymond H. Ives, 663 Kempsville Rd., Norfolk 2, Va.

FOR SALE—Heath TV sweep gen. no. 1 for sale cheap $22.50; Speco sig. tracer $15, all prepaid, or swap. August Palermo, 2230 S. Winebiddle Ave., Pittsburgh 24, Pa.

SELL OR SWAP—15 ass'ted plug-in coils 80-10 meters, B&W and Bud end and center links, junior and baby sizes, 50c ea. post paid. P. Boothroyd, Costas Ct., Rt. 6, Lodi, N. J.

FOR SALE—Carron and Waldom wholesale Speaker Recone stock. Assembled cones, cones only, voice coils, spiders, etc. Will sell entire stock at 50% off factory net price. Hobby Wholesale, 1065 Third St., San Bernardino, Calif.

FOR SALE—Mod. 120 3½" GE AC-DC voltmeter 0-15, 150 and 750 v., white dial; mounted on walnut bakelite panel 7x8x1/8", lettered figures, switches, pin jacks, etc.; portable carrying case $32.75. R. C. Wilmarth, 927 9th Ave., San Diego, Calif.

WANTED—35mm camera. Will swap 522 receiver with built-in power supply operating on 2 meters, also new Bud VFO 21. M. Green, 38 Gautier Ave., Jersey City, N. J.

SALE OR TRADE—Synchronized Clarus MS 35 camera, like new, with Wollensak Raptar coated F2 lens, for comm. rec. in equal cond. or cash. Al Werhan, 103 Wesley St., Manlius, N. Y.

FOR SALE—FADA 795 FM tuner, 88-108 m. c., late type; R.F. stage ratio detector, built-in aerial, power recept., transformer operated, plastic cabinet $17. R. Lytwyn, 1036 Royal, Royal Oak, Mich.

FOR SALE—NC-100 rec. with matching spkr $70. VHF-152A converter $60. Larry Macaluso, 7 Hadik Pkwy., S. Norwalk, Conn.

SWAP—Full size violin with case in good cond., cost $60. Want good tube checker and sig. gen. B. Zaino, 49 W. 225 St., New York 63, N. Y.

SELL OR TRADE—Supreme Audolyzer, mod. 562, comp., perf., inst.; Rider TV no. 1, Rider Changers, Mod. Railroader Mags 1937 to 1952, some bound, perf. Need sweep gen., typewriter, cash or ? Farmers Radio, Aurora, N. C.

FOR SALE—1401S Concertone tape recorder, carrying case, monitor amplifier, hi-fi 8" spkr.; sold for $432.50, sell $300 including Shure no. 55 dynamic mike, stand, 40' cable, 3 N.A.B. 2500' reels of plastic tape. Ernest Siegel, 181 Pacific St., Paterson, N. J.

FOR SALE—5CP1 cathode ray tubes $3.50 ea.; BC929A 3" scope, like new $25; BC-412B 5" scope $35, and many more items. Bernard Soroka, 5341 Cordelia Ave., Baltimore 15, Md.

FOR SALE—Meissner Analyst comp. with tubes, and inst. book $60. Berman Distributing Co., 1188 Broadway, Brooklyn 21, N. Y.

SELL OR SWAP—Sam's photo-folders 1-64, still in original folders. All offers considered. Louis Vargo, 529 Railroad St., Windber, Pa.

FOR SALE—Erwood freq.mod. Mk. 100, ser. A24; mfd. for Navy BuOrd.; in working cond., best offer takes it. Alan Rogovin, 41 Park St., Brookline, Mass.

WANTED—7-tube Silvertone radio chassis number 101.859-2 for use in BC-FM rec.-record changer comb. no. 67. Would buy comp. console if priced right. George Kregolis, R. R. 1, Effingham, Ill.

FOR SALE—Triplett ohmmeter mod. 630 $27.50; Triplett tube tester mod. 3413 $50; Triplett Sig. gen. mod. 3432 $50. All 3 $115; all A-1 cond., less than 2 years old. Arcade Jewelry & Radio, Crawford, Neb.

WANTED—Tuning unit for Delco auto radio mod. R-697. G. H. Swiska, 109 E. School St., Woonsocket, R. I.

FOR SALE—Craftsman RC 8 FM and AM tuner with 10 kc. filter; 2 hi-fi amplifier 6K6-6L6 push pull output. L. P. Orlowski, Dunlap, Iowa.

WANTED—Any model of Emerson radio from 1950 up to date. Archer's Radio, P. O. Box 2, Daytona Beach, Fla.

WANTED—Howard Sam's Red Book, First Edition. Jerry M. Pelton, P. O. Box 185, Rock Falls, Ill.

SALE OR SWAP—Weston model 695 power level meter with 7 ac ranges and 11 db ranges; Philco model TB-2 TV booster. Both exc. cond. L. D. Dillin, 2445 N. Orchard Dr., Burbank, Calif.

SELL OR SWAP—Triumph 3" scope; Simpson 260 VOM; GE wet cell portable; Zenith AM-FM combo 78 rpm console; table 11" TV; Precision 954 tube and VOM checker, etc. Need Hickok 209A. John Pellock, 1415 E. Leafland, Decatur, Ill.

FOR SALE—Bug "Vibroplex" in perf. cond. Used little; will pay shipping, $8. Louis Ciancio, 5153 Dearborn St., Pittsburgh, Pa.

WANTED—Coin-operated hotel radios, any make. State price and time setting. Richard C. Venuti, 137 Johnston St., Newburgh, N. Y.

FOR SALE—TV and radio shop; largest dealer in this territory. Two Omaha TV stations come in strong. Large building on Main St.; well established. Proved money maker. GE, Admiral, RCA franchises. City 10,000. Only $6,000 will handle. Health — must sell. Arends TV Center, 513 W Sheridan, Shenandoah, Iowa.

FOR SALE—1-168 Sams; Sylvania 216 sig. gen.; cap. analyzer; Hickok VTVM; AF gen. and other test eqpt. Also RCA 16 mm sound projector, parts, etc. Wm. P. Henninger, 27 N. Market St., Elizabethville, Pa.

WANTED—Small portable transceiver modulated, 28 mc. or higher. Jim Chatham, 539 Westview Dr., Winston-Salem, N. C.

SELL OR TRADE—Brush BK-401 tape recorder in very good cond., carrying-case mounted, new heads and motors, for 16" or larger TV, or cash. Also recorded paper base tapes. Soundpaintings, 2121 Renrock Rd., Cleveland 18, Ohio.

SALE OR TRADE—16mm movie projector, Eastman mod. A; Kodascope in very good shape, metal case, 500 w. bulb. Masco musical instrument amp., brown leatherette, 18 w. output, mod. MAP-15; radios, crystal mikes. Want sweep gen., sig. tracer, cond. tester. John Arnold, P. O. Box 84, Bluffs, Ill.

WANTED—Binoculars. Will buy or trade. Have Hallicrafter S-20R or 12" Jensen in good home made bass reflex cabinet. V Di Carlo, 28 Marine Ave., Bklyn. 9, N. Y.

TRADE—Eico FM-AM sig. gen. and Eico tubetester, latest models assembled, brand new. Want National or Hallicrafter rec., or good portable. Howard J. Spicer, 341 Byron St., Camden 2, N. J.

SALE OR TRADE—Hickok 195 5" scope, perf.; Cort 17-jewel man's wrist watch, like new. E. G. Bartlett, Atlanta, Mo.

SELL OR TRADE—Ham gear and parts, tube tester and tubes. Write for free list. Alfred Freitag, 1437 Patapsco St., Baltimore 30, Md.

SWAP OR SELL—Send for list of more than 100 technical books, various subjects, exc. cond. F. Bogart, Box 2707, Paterson, N. J.

FOR SALE—Postpaid. Supreme 504A tubeset tester $22.50; Bogen 15w PA amplifier, poor cond. $17.50; ICA Deluxe Code osc. $7.50; Bud WO-6 phono osc. $4.50; National dial type N vernier $2.50. Phil Hurst, Box 63, Lamar, Mo.

FOR SALE—Telephone line tester with intercom for 6 v.d.c. Can be used as is or for parts $5; exciter unit for T17 mike for mobile use $2.50. Gordon Bredy, Rt. 4, Morris Minn.

WANTED—C.Q. Magazine for March, June, and July, 1945. State price and cond. Sylvester Pindroh, 2652 Woodland Ave., N. S. Pittsburgh 12, Pa.

WANTED—3" Pilot TV rec. Reply by mail only, stating price, cond., etc. A. S. Cooke, 21 St. Pauls Court, Brooklyn 26, N. Y.

FOR SALE—100 famous make TV field strength meters; reads in microvolts. Reg. $89.50, special on new 1953 models. Guaranteed, shipped prepaid $62.50. Free comp. TV course with each order. Radiomart, Sheridan, Pa.

FOR SALE—4 tube bat. radio; SCR-522, almost new; Viking I transmitter, never used $254; Rme-84, slightly banged up case, used 10 hrs. $75; Freshman Masterpiece trickle charger. John Gilbert, 1022 Third St., Brookings, So. Dak.

WANTED—Radio - Electronics magazines, Gernsbeck, from Nov. '50 through Oct. '51; state price. Michael Bozoian, 702 Fifth St., Ann Arbor, Mich.

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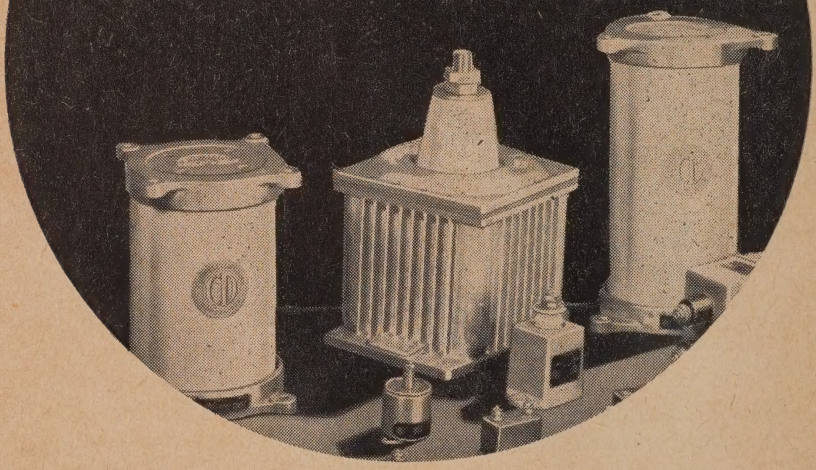

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